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# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



## THESIS

### INSTRUCTIONAL DESIGN OF COMPUTER-BASED TRAINING

by

Robert W. Foster  
Alfred B. Price, Jr.

December, 1996

Co-Advisors:

Tung Bui  
Anthony Ciavarelli

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## INSTRUCTIONAL DESIGN OF COMPUTER-BASED TRAINING

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Submitted in partial fulfillment  
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## ABSTRACT

The goal of this research is to combine the principles of instructional design and computer technology in order to produce a multimedia computer-based trainer for the Aviation Night Vision Image System and Heads-up Display (ANVIS/HUD). The technological advances in night vision goggles like the ANVIS/HUD system have permitted aircrews to accomplish numerous night mission tasks which they were not previously capable of completing. Increase in mission tasking requires the operators of the ANVIS/HUD system to obtain a large amount of ANVIS/HUD training to ensure safety of personnel and equipment as well as mission success. The Department of the Navy's training budget is being reduced and the need for unconventional training methods to augment the cockpit and classroom is essential. The use of computer-based training provides the technology to achieve this training requirement. By providing a means to apply innovative instructional design principles and multimedia computer technology, the training of the war-fighters is expected to be accomplished both effectively and efficiently thus saving lives and money.





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## I. INTRODUCTION

The current Military Technical Revolution has changed the face of war as we know it. The military technologies of the past such as gunpowder, artillery, machine guns, airplanes, fixed, and rotary, as well as nuclear weapons all changed the doctrine and thus the approach to prosecuting war. Today, the technology of night vision equipment has dramatically changed the way we conduct military operations. The unique capabilities of platforms using this technology has been recently demonstrated in Desert Storm. General Norman Schwarzkopf indicated the use of night vision goggles (NVG) in a hostile environment was instrumental in ensuring successful operations, because the use of NVG's and other sensor aids permitted many missions to be conducted under the cover of night. Night vision goggles allow aircrews to perform night missions by amplifying low level ambient light, so that pilots can see. A properly training pilot can perform mission tasks using NVG visual information, but must be cautious to also maintain his/her visual scan of flight instruments. The newly designed ANVIS/HUD was developed to integrate a pilot's outside, NVG assisted, visual scan, with the essential instrument flight data. It is believed that the combination of enhanced night vision used with readily available flight information in a Heads-up display format, will improve a pilots situational awareness, and overall mission capability.

The night vision goggle technology in the aviation community has evolved into the Aviators Night Imaging System/Heads Up Display (ANVIS/HUD). This evolution was designed to reduce the fatigue on the pilot operating the system and thus increase

mission success. This mission success is only accomplished when the operators are properly trained with the use of the night vision gear. This training is costly and with current budget reductions inevitable, the Navy requires new innovative thinking to solve the training dilemma.

Throughout the Department of Defense the motto is ,“do more with less”, and the training of its personnel is not excluded from this message. Many reports and studies have indicated the use of computer-based training (CBT) to be an effective and efficient method of training. The computer is not a panacea, however, it can be designed to be an excellent education and training tool. This thesis will examine why a computer-based training system is advantageous, and demonstrate the methodology used to create a CBT for the ANVIS/HUD system.

## **A. PURPOSES**

The Aviation Safety School at the Naval Postgraduate School is under contract by Naval Air Systems Command, Code PMA-205L, to provide enhancements to the baseline version of the Aviators Night Imaging System/Heads Up Display (ANVIS/HUD) computer-based trainer. The ANVIS/HUD system combines night vision goggles (NVG) and a heads-up display (HUD). This combination mounts the NVG forward of the eye and enables the pilot to view instrumentation in the eye piece. This system is planned for installation in the Navy's 1553 data-bus configured rotary wing aircraft. Computer-based trainers for the ANVIS/HUD system have been developed for both the UH-1N (Huey) and the HH-60H (Seahawk) helicopters. The primary purpose of this

research is to improve the methodology for developing computer-based training. This improvement is made by following instructional design principles and through the use of a systematic development approach. The second purpose is to create a new computer-based trainer module for night vision goggles in rotary wing aircraft. This module incorporates multimedia enhancements which are designed to motivate the learner.

## **B. OBJECTIVES**

The tasks to be accomplished in order to meet the purposes as specified above are to:

1. Learn the Computer-based Training software (Asymetrix Toolbook 4.0 CBT).
2. To develop a systematic approach for development of a computer-based trainer (CBT), using Interactive Courseware guidelines, Military Training Programs (Military Standards 1379D), and Instructional design principles.
3. Develop an instructional design quality checklist to evaluate the CBT module developed.
4. Provide a means of user feedback for improving future versions.

## **C. BACKGROUND, PREVIOUS DEVELOPMENT AND COMMUNITY**

A Night Vision Goggle (NVG) training technology report prepared by Naval Postgraduate School for Naval Air Systems Command (PMA-205), December 1994, indicated a need still exists to find enhanced methods for teaching NVG performance limitations and visualization of the night environment. The improvement in

performance is based on the premise that students (pilots) need repeated exposure to the night visual environment to build essential skills and knowledge such as correct scan, perception of nighttime visual scene variations and recognition of goggle performance limitations.

The 1994 NVG study reviewed advanced technologies available to improve presentation of the night vision environment with particular emphasis on enhancing visualization skills and training. Two key technology areas reviewed and discussed were: (1) the application of low-cost simulation, devices using high-resolution helmet-mounted displays as a means to provide hands-on visualization training to supplement training in the aircraft or dome simulator, and (2) the use of computer-based, multimedia technology explored as a way to augment NITE lab training.

The NVG study recommended that research and development efforts continue in order to develop new instructional presentation methods and to further explore the use of these emerging technologies in the NVG training area.

#### **D. SUMMARY OF PREVIOUS DEVELOPMENT**

A "baseline" interactive CBT for the HH-60H was developed by two thesis students from Naval Postgraduate School (Shaffer and Kern June 94), based on a previous system developed for the UH-1. There were four modules in the HH-60H CBT which were comprised of course overview, symbology, operation and maintenance of the ANVIS/HUD, which were developed using Asymetrix Multimedia Toolbook 4.0 CBT edition.

The Asymetix Toolbook CBT software product was chosen as the development medium primarily because a capability comparison of authoring tools detailed in Appendix (A) indicated Asymetrix met or exceeded functional requirements for this thesis. Some secondary reasons for choosing Asymetix CBT were: cost of acquiring new software efficiency of converting existing modules created in Asymetrix CBT, and the learning curve associated with a new software.

The ANVIS/HUD system is being deployed to the fleet and employed in specific helicopter platforms. This thesis will support follow-on development of the ANVIS/HUD for the HH-60H helicopter by providing a foundation for the design and development process, as well as prototypical examples of CBT training modules.

## E. COMMUNITY

The two Helicopter Combat Support Special (HCS) squadrons in the Navy; HCS-4 and HCS-5 are located at Norfolk, Virginia and Point Mugu, California, respectively. The HCS community spends most of its time preparing and practicing the tactics used in performing its primary missions. The two missions are Special Warfare and Combat Search and Rescue. Both missions are similar, requiring HCS crew to train for operations in extremely hostile areas. Recent developments in technology, i.e., ANVIS/HUD have enabled the operations to be conducted under the challenge of the night-time environment. The Special Warfare mission involves the insertion and/or extraction of highly specialized units (i.e., Explosive Ordnance Disposal or Navy SEALs) in covert areas, while the Combat Search and Rescue



mission involves rescuing downed aviators or stranded service members from a hostile environment. In support of these hazardous missions the HCS community is being equipped and trained on numerous "high-tech" weapon systems. Some of the enhancements included the GAU-17 gatling gun-style weapon which fires four-thousand rounds a minute, the Hellfire missiles and the ANVIS/HUD system. The ANVIS/HUD system provides the pilot a night vision capability with a heads-up display of important flight instrumentation data which reduced the need to scan cockpit instruments. This community trains and prepares to perform in a variety of capacities, and is prepared to deploy on a seventy-two hour notice.

The HCS squadrons have more than adequate computer equipment, but are limited by personnel assets. For this reason alone, an HCS squadron is an ideal environment for a CBT program for the simple fact that instructors are not as accessible as computers. In addition, all the Operational Flight Simulators and Weapon System Trainers for the HCS community are located at HS-10, the Fleet Replacement Squadron in San Diego, CA., which is not efficient for the training of either HCS squadron. Hence, both HCS-4 and HCS-5 must conduct innovative on-site training either in the classroom, in the cockpit, or on a computer.

#### **F. PROBLEM STATEMENT**

Computer-based training for ANVIS/HUD NVG can be accomplished if the instruction developed provides value added to a student over and above the instruction gained in the classroom and cockpit. This value added can be accomplished when

efficient and effective repetition of key elements are provided to the pilots. This can be realized in a computer-based training module which encompasses key points of the HH-60H ANVIS/HUD trainer and enhances the instruction with multimedia. The module will be used as:

1. a basic introduction of the night environment for rotary wing aviators.
2. a refresher for rotary wing aviators returning to flight status.
3. a refresher for rotary wing aviators to maintain currency training level in the ANVIS/HUD operations.

#### G. NORMATIVE DEFINITIONS OF TERMS

Authorware: A high-level language used to develop multimedia presentations that contains graphics, audio, text, animation and video elements.

Graphical-User-Interface (GUI): A graphics-based user interface allows the user to select files, programs or commands by pointing to a pictorial representation on the screen rather than by typing long, complex commands from a command prompt.

Object-Oriented Programming (OOP): A programming model that views a program as a set of self-contained objects that interact with other objects by passing messages between them.

#### H. SUMMARY OF APPROACH

The development of the CBT module is divided into six phases.

1. Obtain and configure hardware and software for multimedia.

2. Become familiar with the Asymetrix CBT authoring software
3. Develop an Instructional Quality Checklist.
4. Develop an Instructional Design Methodology for multimedia training systems.
5. Develop learning objectives for module.
6. Create a CBT module for the HH-60H.

## I. IMPORTANCE OF STUDY

The Department of Defense's budget reduction has forced leaders to solve problems by leveraging technology and thinking in unconventional manners. There is increased pressure to do more with less in every facet of the Defense Department, and training is no exception. High quality training systems are required to ensure personnel are armed with the skills and knowledge of their equipment to go into harms way, however, the funding to support the level of instruction required is dwindling. Specifically, the recent down-sizing within the Department of Navy has forced most fleet aviation components to operate with minimum training resources. A prevailing working doctrine stating that, "we must do more with less", dictates that aviation commands must meet readiness goals as efficiently as possible.

The Navy has often relied and sometimes over-relied on advanced technology to improve efficiency and force effectiveness of the missions. The assumption is that our forces can correctly use these technologies to their benefit in attaining readiness goals and improving mission performance. Specifically, the ANVIS/HUD system may provide a potentially greater tactical advantage for the pilot because it provides improved situational

awareness. The system may also impose a greater burden for comprehending a new complex piece of equipment and capabilities and limitations that are inherent in the operation of the gear. In short, aircrews are under more pressure than ever to understand the constantly changing number of assets that are available to them; hence, the training systems that are delivered must be, cost effective and provide positive training.

Throughout the history of Naval Aviation the training of pilots has always been a costly endeavor. The costs are reflected in both dollars and in the loss of human life. Many missions are now being conducted under the cover of darkness and training pilots for operations in the night environment is, as one would expect, even more hazardous. The costs of neglecting NVG training measured in life and equipment cannot be overlooked. The training budget constraints for deployable units is being reduced and the need for efficiencies is critical to operational success. With the monetary constraints imposed on training many commands are researching the applicability of computer-based training to solve their requirements.

## **J. SCOPE AND LIMITATIONS OF STUDY**

Concentration on a single training system or CBT module was necessary to ensure the instructional quality checklist and the instructional design principles were accurately employed to develop a quality CBT module. This module provides excellent instructional review of the HH-60H, ANVIS/HUD. However, it is not designed as a stand-alone training device. It is designed to supplement training conducted with the HH-60H computer-based trainer, training in the ready room and training in the cockpit.

When assessing the scope and limitations of the project in detail, the following points should be noted:

1. Development for the HH-60H ANVIS/HUD is still in progress. The imagery available for ANVIS/HUD development at this time is limited, however plans for future development incorporating new and more relevant video imagery, as well as use of synthetic high-resolutions imagery for simulating key features of the night environment.
2. Because the equipment is at the test level, hands-on experience with actual equipment was limited.
3. Since there are very few military personnel who have actually flown with the current version of the HH-60H ANVIS/HUD equipment, subject matter experts were scarce.

Despite these limitations, the CBT product that is produced using instructional design methodologies developed here is expected to provide a reinforcing training tool for night vision missions flown by fleet aviators.

## II. REVIEW OF RELATED LITERATURE

The literature presented in this study shows computers are being used to improve efficiency and effectiveness in all aspects of the military and business. One area of computer use is in the domain of training personnel. Training military personnel is necessary to ensure that equipment is operated correctly and safely. Complexity of military operations have increased in recent years along with the human performance needed to operate and maintain the equipment. The ANVIS/HUD is an example a complex piece of gear used in the rotary-wing community. The deployment of these complex devices is straining the training budget while limitations such as time and funding are making training and readiness difficult to accomplish (Fletcher,1995).

There is a misconception that computers will solve the dilemma of "doing more with less". The computer is not a panacea, however, it can be used as an excellent education and training tool. With the rapid proliferation of personal computers, and advances in computer-based instructional systems, the Department of Navy must consider computers as a partial solution to their training needs. There are two military instructions specifically dealing with guidelines for development, acquisition, and management of interactive courseware (ICW). The first is Department of Defense Instruction 1322.20 (March 14, 1991) and the second is Department of the Navy OPNAV Instruction 1500.73 (July 28, 1992), currently under revision. The overall military standard for military training programs is outlined in Military Standard 1379D (Dec 1990).

## 1. The History of CBT

It has been about three decades since educators and computer scientists began using computers for instructional purposes. During the 1960's and '70's computing took place on large mainframe computers (largely IBM's), which were very costly to purchase and maintain. This exorbitant cost provided a significant barrier to overall use of computing power. Most educational computing took place at the university level and was largely used for writing programs and text processing.

There was one government funded CBT project in the '60's at the University of Illinois, named PLATO. The PLATO project successfully integrated both text and graphics which provided instructors with the first programming environment for computer-based training (Albert, 1970).

During the '80's the microcomputer user base grew and the release of the IBM Personal Computer or microcomputer was unveiled in 1981. The release in 1984 of Apple's Macintosh microcomputer provided many enhancements not previously seen in personal computers. This microcomputer provided better integration of text, graphics, added voice and music capabilities and used the mouse for I/O as well as drawing art on the screen. By 1989 the NeXT microcomputer had incorporated the attributes associated with a Macintosh but enhanced the speed of processing, size of storage and enabled the use of networking. Since that period, incredible advances have been made in computer technology concerning both availability and user acceptance. The most recent developments in microcomputer technology provide enormous

power and ease-of-use through advanced visual, auditory and I/O devices which has led to the use of interactive multimedia in training scenarios.

With the more powerful hardware available, the software's utility (speed and functionality) has risen exponentially. The authoring systems that were virtually unheard of only four years ago are common place in end-user computing today. The complexity of authorware has been dramatically reduced by the use of graphical-user-interface (GUI) and object-oriented programming (OOP). An authoring system enables a user to develop a computer-based training system in a reasonable amount of time and with very robust capabilities. To take advantage of the computer's particular instructional capabilities, CBT must be developed when the training benefit of CBT can be justified. Situations where costly traditional methods of instruction are employed provide perfect opportunities for CBT. The situations where conventional instructional methods are used are numerous in the Department of Defense/Department of Navy (DOD/DON) and most are in need of revision or overhaul.

Unfortunately, the history of computer-based training is filled with instances of poor design and implementation problems. Kearsley, Rendle and Seidel (1983) along with Alessi and Trollip (1991), reviewed the history of early efforts to develop high-quality instruction delivered by the computer, and reported some lessons learned. A more detailed presentation of design and development procedures, and prescriptions for improving CBT instruction is presented by Gery (1987). Her credentials are substantially validated by her extensive experience with both good and bad examples of CBT. The



most common pitfalls of poor design and implementation of computer-based training are addressed next. Learning objectives must be defined and clearly stated in a CBT. The evaluation and testing must exactly match the stated learning objectives. The presentation of the material should be consistent throughout and not distracting nor overloading to the student. These pitfalls can be avoided if some general guidelines are followed.

Development is based on a cycle of plan, draft, evaluation and revision until the product meets the objectives specified. Poor CBT design often is a result of recipe-style instructional design wherein the developer never incorporates creative ideas. There must be a considerable amount of time dedicated to the discussing and planning before the drafting of ideas and the final implementation on a computer. CBT development must follow the principles of cognitive psychology which include perception and attention, memory (short-term and long-term), comprehension, active learning, motivation, transfer of learning and individual differences.

The fundamentals of instructional design must be followed to ensure a quality product however, creativity is necessary in CBT, and without it, the computer training field is unlikely to be fully exploited.

In order to improve instructional quality, specifically for CBT, some authors have published design and development guidelines which provide advice at each phase of CBT development. One of the most useful sources providing such guidelines is found in Alessi and Trollip's (1991), Computer-Based Instruction: Methods and Development, which presented a step-by-step process of CBT development, including instructional design principles, development templates such as story boards and guides for computer screen

layout. In the special case of multimedia technology application, Oblinger (1992), specifically focuses on different kinds of media (audio, video, graphics and animation) and the appropriate application of each in a CBT.

A comprehensive review of instructional design principles was presented by Ciavarelli (1994), but will not be repeated here. This review on instructional design was based on prevailing theories of instruction by Gagne' and Briggs (1979), Mager (1984) and Merrill (1980, 1983). By way of summary, these instruction design experts maintain that the quality of instruction, whether delivered by computer or not, is dependent upon the key principles of design which include: (1) careful specification of learning objectives, (2) formation of instructional strategies for the delivery of instruction based on the content and performance requirements specified in the learning objectives, (3) adequate student guidance, and organizing instruction to promote learning, (4) evaluating student progress, and instructional effectiveness using tests based explicitly on the stated learning objectives. If any of these four instructional design elements are absent during development, or are missing in the instruction, the quality of the learning value of a course is seriously compromised. Conversely, if these elements are incorporated into the CBT the learning and retention potential of the student can be enhanced.

When developing any training programs (CBT included) for the government there is a military's standard which should be followed, namely, MIL Standard 1379D (Dec 5, 1990). The ultimate goal of MIL-STD-1379D is to enable the government to identify more accurately the data or information that the government must have to fulfill a training requirement. The current trend in the government is to reduce the use of

cumbersome military specifications which slow down the contractors development of an end product. In the case of MIL-STD-1379D, the instructional design areas covered are “in-line” with the literature reviewed and such guidelines are considered helpful in the process of CBT development.

## 2. What is Computer-based Training?

Numerous terms have been used to describe what we call “Computer-Based Training” (CBT). Computer-Based Training encompasses the definitions of both computer-assisted training and computer-managed learning. The key domain areas of CAT and CML are provided in the table below:

Computer-Assisted Training (CAT)	Computer-Managed Learning (CML)
<ul style="list-style-type: none"><li>■ Tutorial</li><li>■ Simulations</li><li>■ Drills and Practice</li></ul>	<ul style="list-style-type: none"><li>■ Testing</li><li>■ Reporting</li><li>■ Storage and Routing</li></ul>

Computer-Assisted Training/Instruction (CAT/I) is defined as the use of a computer to provide educational exercises, such as drills, practice sessions, simulations, and tutorial lessons for a learner (Glynn, 1986). Computer-Managed Learning and Instruction: (CML/I) is a CBT application which the computer manages a learner’s progress through a training program. A CML system supports instruction by selecting, presenting, and scoring tests, recording students progress data and providing feedback on drills and test performance (Gery, 1987).

A common definition of the above terminology is required to proceed, so for the purpose of this thesis, "computer-based training" (CBT) is defined as:

*An interactive learning experience between a learner and a computer in which the computer provides the majority of the stimulus, the learner must respond, and the computer analyzes the response and provides feedback to the learner.*

This definition includes interactive video and other multimedia programs when they are computer driven (Gery, 1987).

With the terminology defined the question of why use a computer-based trainer can be addressed. Computers and their utility are permeating every aspect of our lives, and the educational arena is no exception. Many of the characteristics and methodologies of good instruction/training can be incorporated into computer-based training, given the current state of technology. The production of new-generation microcomputers has resulted in better sound and graphics capabilities, and for the first time, authoring systems for creating computer-based instruction are widely available, reasonably priced and "easy" to use.

### **3. What are the advantages and disadvantages of CBT for use in the ANVIS/HUD trainer?**

The advantages and disadvantages of computer-based training for ANVIS/HUD are combined into six categories. The categories consist of objectivity and standardization, individualization and repetition, multiplicity and decentralization, cost-effectiveness, needs orientation, control of learning success.

The first area of concern is the *objectivity and standardization* of computer-based training programs. Training inconsistencies and biases can be eliminated from an

instructional perspective with the use of computer-based trainers. A CBT program quality is usually high because it is produced by a team of experts usually consisting of graphic artists, programmers and content experts. By using the computer to deliver instruction, each student receives the same uniform training (even though it may be delivered in different places at different times) and a high degree of standardization can be achieved (Kearsley, 1983). To ensure quality, after the CBT is created the content and methodological acceptance are examined in a field test. Consistency can be obtained because the learning content is not undermined by the subjectivity, influence of the trainer or by interruptions in the training process (Gotz 1991).

A limitation to objectivity and standardization in computer-based training is that it does only what has been programmed. Once a CBT is programmed there is a limited or finite number of responses to a infinite number of user questions. Therefore, clarity in the instructions is paramount to ensure the student is queried correctly. The ANVIS/HUD expert skill base is limited, specifically, in the operational/mission related skills required to operated the system safely. This limitation must be anticipated, and as pilots become proficient in their skills, more lessons learned material must be made available. Additionally, procedures for updating and revising CBT instruction must be incorporated into and overall training plan to avoid possible negative training.

Second is the *individualization and repetition* of CBT . Learning is more conducive if the subject is individualized to meet his needs. A real benefit of CBT is that the skill and knowledge levels of students can be assessed at the beginning of training, and individualized learning programs can be created to match their level (Kearsley, 1983).

Currently, the ANVIS/HUD CBT focuses the student on the basic knowledge learning objectives. However, there are plans for the operational skills to be developed in later revisions. Computer-based training systems force the students to focus on topics that require more emphasis. With the student in control of the CBT there is the ability to repeat the more difficult topics and skip over the modules that are more easily understood. The CBT is self paced which allow the students to progress through the material at their own pace. There is no need to gear the training to the speed of the slowest learner, as is often the case with classroom instruction (Goverts, 1984). Provided the resources are available, the student can designate the time and place of learning.

Advanced programs offer different paths of instruction in the processing of instructional material. The amount of material can be selected according to the skills and qualifications of the learner. Repetition can be accomplished using a knowledge control or classification of test results integrated into the program, and then the learning sequences can be repeated as often as needed (Gotz, 1991). A disadvantage of individualization is that the CBT is not easily combined with group activities.

Because of the CBT's individualized nature, it is sometimes difficult to integrate with other training processes. This can be a severe limitation when trying to integrate CBT with classroom instruction (Goverts, 1984). The ANVIS/HUD computer-based training system was designed to augment the training performed in the classroom and cockpit. The technology of today has enhanced the integration of stand-alone training system with classrooms; however, caution must still be employed when integrating a stand-alone CBT with other conventional training methods.

The third area to be discussed is *multiplicity and decentralization*. The military has limited simulation and actual training locations for the ANVIS/HUD. The user base is diverse in level of skill and knowledge, additionally the student population is varied and dispersed in relation to the training commands and simulators. This diversity may indicate the need to establish local training options, and the CBT as one possibility for meeting this requirement. Computer-based trainers can be delivered to any site that has the required equipment with the minimum support resources needed. Thus one advantage to using CBT with a geographically scattered student population is students can be trained without gathering them at one point or sending an instructor on travel to conduct training at each site (Goverts, 1984).

A larger student audience will normally be reached using CBT because the transportation and scheduling considerations associated with a central training facility represents a major obstacle to providing timely and cost effective training. Currently, most CBT systems are produced on CD-ROM with media support or interact from other peripherals. With this method of delivery, the most pronounced decentralization disadvantage is that once the CBT is "published", a program needs to be in place before a modification or update to a developed training module can be incorporated. The quality of the learner program is therefore dependent on the grade and timing of the update. This becomes a serious problem if the content and the learning objectives do not remain constant over the longer period of time (Gotz, 1991). The updating obstacles for CBT may be overcome when technology advancements in bandwidth allows for true, full

motion multimedia web-based training, and thus "real time" updates and modifications are made possible.

A specific budgetary question for the justification of a CBT is: "Will it be *cost-effective* to develop a CBT or use a traditional method of instruction in a military application?". The military currently uses CBT in conjunction with simulators to reduce the amount of actual flying time required for training. The Navy has reduced pilot training costs from \$5,000 to \$400 per hour in one of its programs through the use of computer-based simulation (Kearsley, 1983). A study by Fletcher (1995) compared initial investment costs along with operating and support costs for CBT to associated with traditional methods of teaching. In this study the lower the ratio, the less costly, in relation to CBT versus conventional methods of training. A review of cost studies in military training reported that the ratio of computer-based training over conventional training approaches averages 0.43 for initial investment and averages 0.16 for operating and support costs.

Since the learning programs available on the market are relatively inexpensive in comparison with new development in-house (learning programs), the cost for trainers (e.g. honorarium and travel costs) can be reduced to some extent (Gotz, 1991). A disadvantage of the past was a large initial investment in equipment or on-going leasing charges, which led to CBT previously being an expensive training method (Goverts, 1984). The minimum requirements for a desktop multimedia systems are outlined in Multimedia Extensions to the DOD Minimum Desktop Configuration (Williams, 1995).



The recommended capabilities for a multimedia development system are substantially higher than the minimum desktop computer.

The recommended minimum configuration for multimedia development is:

1. A central process unit (CPU) with 32-bit data path.
2. 256K cache memory, 32MB of RAM.
3. Hard disk drive(s) with capacity of 2GB with burst transfer rate of 10MB per second, average transfer time should be 10ms or less and 3.5 inch floppy.
4. Display controller capable of a minimum of 64K colors, 1280x1024 pixels at 72Hz refresh rate.
5. 101-key keyboard with mouse.
6. Quad speed CD-ROM.
7. bit stereo sound card and speakers.
8. Sufficient serial, parallel, and SCSI ports and extra slots to support all desired peripherals.

Optional components recommend are:

9. Scanner with 1200 dpi.
10. Video output to Super VHS and video capture.
11. Wave table and MIDI support with Microphone.
12. CD-ROM writer.
13. Video camera and color printer.

These recommended requirements for a multimedia desktop system are designed to be a starting point for the initial cost estimate of resources required. In considering development time, CBT normally takes more time to develop than other training methods. The programming and debugging process is time-consuming, however, software advances are reducing the development cycle in both time and money. Typically more thought and planning go into development and more care is taken in the design of CBT because students easily can become lost if the instructions on the screen are unclear (Goverts, 1984).

Providing the exact learning objective(s) is a very difficult task for the instructional designer when developing a CBT. The *needs of the student* are the crux of the training and thus must be the main focus in the process. To help meet the student's needs for "hands-on" skills training the use of simulations are possible. The animation capabilities of the computer make it possible to simulate a wide range of situations. These simulations can be substituted for on-the-job training which would "tie-up" operational equipment (Goverts, 1984).

Drills and practice are possible. The computer has infinite patience and is the ideal medium for presenting drill and practice such as committing procedures to memory (Goverts, 1984).

Learning can take place directly at the workplace; that is to say, exactly when and where the need for learning arises, just-in-time training. It is not necessary to find a trainer, reserve a seminar room or hotel space, or invest time in organizing all media and course material for each particular course (Goverts, 1991).

It has been shown that instructional approaches based on passive presentation methods, such as classroom lectures and videotapes, result in very little learning - on the order of a few minutes of every hour. With interactive individualized instruction, such as a CBT system, the student spends a higher portion of the time attending and interacting with instructional material and hence, learning can be enhanced (Kearsley 1983). A disadvantage of learning with computer-based training presupposes that the learner has the necessary hardware and software at their disposal. Should the learning and work environment be combined, it is necessary to guarantee that the equipment can be utilized not only for work-related purpose but also for learning-related purposes (Goverts, 1984). We see this limitation going away as computers become more powerful, widely distributed, networked and less expensive. A final note on the time required for development should be addressed. The specific training needs of the student may not be met if the development time is longer than the knowledge cycle, which is the case in many training environments.

The sixth and last area is *control of learning success*. Complex problems that require the student to function on the evaluation and synthesis levels can be presented. The computer can provide immediate feedback for incorrect solutions (Goverts, 1984). The student's input can be stored, systematized and evaluated in order to provide immediate feedback on the status of acquired knowledge. A computer-based training system can be used to register students, assign training schedules, generate and score tests, produce reports on student progress and utilization of training resources. One of the largest computer-managed instruction (CMI) systems is used by the Navy. This CMI

manages the daily instruction of 10,000 students in twenty-four courses at nine training schools. A disadvantage in the area of controlling learning success is learning with the computer requires the protection and security of the learner's data. Comments on the method of instruction, time of instruction, and mistakes made require the permission of the learner and the protection of such data is the requirement of the training activity (Goverts, 1991).

The advantages and disadvantages could have been compiled into different headings however, the usefulness of CBT is still valid and has remained somewhat constant over the period 1983 to 1991. While it is possible that a single benefit could be sufficient justification for ANVIS/HUD CBT, normally a number of needs are addressed simultaneously. The one thing that was dynamic during this period is the proliferation, acceptance and effectiveness of personal computers throughout the work environment. The technological limitations of hardware and software are rapidly being overcome and the user acceptance of computers is increasing dramatically.

#### **4. What is the future of CBT in military applications?**

Computer-based instruction has been used since the early 1970's, however, only recently has the technology been able to support the demands of the developers and the requirements of the learner. A review of literature can only indicate where CBT has come from and where it is now, but with a little imagination there appears to be endless possibilities for computer-based training the future.

Two examples expressing where CBT authorware has evolved from can be found in articles published by Govaerts, 1984 and Geber, 1994. In the infancy of computer-

based training the development technology limited CBT application and customer use due to programming difficulties. In 1984, the main drawback to computer-based training was the laborious task of developing and programming course material. There was no apparent solution to this problem in the future (Govaerts, 1984). This oversight in the advances in technology was contradicted only ten years later. Multimedia has enabled a tremendous advance for developing training programs delivered by technological means. Authoring tools for multimedia have become so simple to use that instructional designers without a computer-programming background can easily figure out how to create a computer-based training (Geber, 1994).

The advances in the world wide web, its ease of use, global connectivity and user acceptance have led to yet another technology to be used for training. The Web-Based Training (WBT) may be compared to current implementation of computer-based training in quality of training outcomes.

There are advantages and disadvantages of WBT when compared to CBT that cannot be ignored. Some of the advantages of WBT are (Kilby, 1996):

1. Easy delivery of training to users.
2. Instant multi-platform capabilities. (Windows, Mac, UNIX)
3. Easy updating of content.
4. Quicker turnaround of finished product.
5. Access is controllable.
6. Options to link with other training systems.
7. Multitasking capabilities suitable for electronic performance support system. (EPSS)

The disadvantages of WBT are largely limitations in technology.

1. Limited formatting of content in current browser.
2. Bandwidth and browser limitations may restrict instructional methodologies.
3. Limited bandwidth means slower performance for sound, video, and graphics.
4. Server access, control usage, and billing to users.

The disadvantages of WBT are limited by today's technology, however, advances in computers and telecommunication are rapidly eroding these disadvantages. The table below indicates the future capabilities of technology needed to expand the WBT (Chute, 1996).

	Today	2000 - 2010
Fiber Optics	45,000,000 bps	1,000,000,000,000 bps
Video Conferences	360	660,000
Micro-Chip Density	32,000,000 transistors	1,000,000,000 transistors

The increased competition in the global economy, world markets and mass customization will require unique technological solutions. The workforce supporting the

global economy will have more career changes and changing skill levels which again will look to technological advances to ensure competency. With increased competition, advances in technology and the changing workforce, some combination of CBT and WBT will be used to gain training efficiencies far into the future. These advances in training will be used by the military to gain efficiency and effectiveness in the training of its personnel. Given the fact that technological limitations are dwindling and the users are accepting the computer for its effectiveness and efficiency, computer-based training must be considered as a partial training solution for the military.

#### **5. Systematic Design**

Regardless of how the advances in technology convey the training a systematic design method should be used in the development process. Although it has not been proven to be the clearly superior method of developing instruction, systematic design is quite effective. Systematic design requires a focus on exactly what the program is intending to teach the student. Computer-based training is a medium of instruction that is unforgiving of sloppy planning (Gery 1987). Each of the pre-defined steps or phases of systematic design work together to ensure the desired outcome.

A systematic design for instructional system is prescribed by various authors but the number of steps and degree of detail are varied. One systematic design is not necessarily superior to the others, however, all provide a road map to help direct the program to its goal of quality instruction.

The following design steps were derived from ( Gagne', 1979; Gery; 1987; Alessi, 1991).

<i>Gagne' 1979</i>	<i>Gery 1987</i>	<i>Alessi 1991</i>
Analysis of Needs, Goals and Priorities	Project Definition (Proposal)	Determine Needs and Goals
Analysis of Resources, Constraints and Alternative Delivery methods	High-Level Design	Collect Resources
Determination of Scope and Sequence of Course	Detailed Design	Learn the content
Determining Course Structure and Sequence	Development (Scripting or Storyboarding)	Generate ideas
Analysis of Course Objectives	Programming	Design instruction
Definition of Performance Objectives	Testing	Flowchart the lesson
Preparing Lesson Plans (Modules)	Production and Distribution	Storyboard the program
Developing, Selecting Materials, Media	Administration	Programming
Assessing Student Performance (Measures)		Produce supported materials
Teacher Preparation		Evaluate and revise
Formative Evaluation		
Field Testing, Revision		
Summary Evaluation		
Installation and Diffusion		

All of the above phases could be categorized in one way or another into the instructional system design model of analyze, design, develop, implement, and evaluate. Regardless of the number of steps from a practical standpoint, systematic instruction is reliable and it can be reused or reengineered for greater effectiveness. Having detailed the need for a computer-based trainer for the ANVIS/HUD and indicated the utility of a systematic approach to the development of a CBT, the amount of time spent in each area should be considered.



6. What percentage of time in the development of a CBT should be allocated to each phase?

A study of several companies and industries found that instructional designers perform distinct tasks while engaged in the development of computer-based training. While there are variations observed in instructional design approaches and methodologies, the following tasks were identified as common to most design processes. The percentages associated with the tasks will vary significantly from project to project, but this provides rough guidelines (Chapman, Aug 95).

Phase or Step	Percentage of Time
Analyze and Outline Content	6 %
Other	14 %
Storyboard	19 %
Produce Media	13 %
Author Course	28 %
Evaluate Course	20 %
Total Time	100 %

**7. Is CBT the correct technology for ANVIS/HUD training?**

Even if there are advantages that support the use of a CBT, the question must be raised: Does CBT work for military training and particularly for ANVIS/HUD tasks? The ANVIS/HUD system was developed after the airframes were designed and the missions were assigned in a bottom - up method. A CBT can be used to provide training in the characteristic of the night environment and the limitations of the ANVIS/HUD. Additionally, as more ANVIS/HUD media becomes available, the human factors associated with its use can be incorporated into future CBT revisions. A research study group for the North Atlantic Treaty Organization (NATO) from 1985-1995 heard 31 papers on the subject of computer-based training. These papers were prepared by forty-one scientists from eight different NATO countries indicates there is significant interest in the area of computer-based training in the military both domestic and foreign (Fletcher, 1995). The computer technology available for training is vast and diverse however, it should only be employed when it "adds value" to the training. The value of training time is of great concern for the military in light of the reductions in personnel and budget. The use of computer-based training reduces time to reach instructional objectives as detailed in a study conducted in 1996. There is a reduction of about thirty percent of time it takes each student to reach a variety of instructional objectives (Fletcher, 1996).

Interaction between the user and the CBT is instrumental in making a productive training tool. When a CBT is designed with interactivity, it becomes more engaging to the learner and thus enhances retention of the subject. Interactivity of a CBT furnishes stimulus or opportunities for the student to think and respond. The program can then analyze the student's responses and provide descriptive feedback. The CBT developed must be engaging and relevant to the learner's situation. It should include enough variety and surprise to create motivation for continuing the lesson. Good computer-based trainers allow the learner to go back and review or repeat segments of the instruction, which enhances retention. Other learning strategies, like mnemonic association, gaming, simulation, and practice with feedback help to motivate and enhance learning and retention. Below are some critical evaluation factors that should be considered before the computer-based training is a viable option (Gery 1987).

1. Repetitive actions must be taught in realistic situation.
2. The subject matter involves making alternative choices based on varying conditions.
3. Safety is a concern.
4. Concepts are difficult to teach without student input, practice and visualization.
5. Concepts must be taught on demand to a varying number of people.
6. If the budget or resources are limited, technology could prove cost effective.

If:

- the course will be taught on a long term basis.
- the learning audience is large or classes are taught repeatedly and often.
- a large number of tests are required.
- evaluation of responses must be recorded and tracked.
- on the job with actual equipment is prohibitively high.

The literature indicates CBT should only be used as a training alternative if it adds value. In other words, paying the price for CBT is justified if the training material can be presented more effectively and if the learner is more likely to be motivated with CBT than with other instructional methods. Using the principles of instructional design a CBT can be developed to add value to the learning experience of pilots operating the ANVIS/HUD.

The two key ideas that emerged from the literature review were the use of a systematic design in the development and the use of instructional design principles. The systematic approach helps conceptualize the design of the system. The instructional design principles help to ensure the subject matter presented to the learner is in the correct format to aid in knowledge transfer. The methodology used to design portions of the training system for ANVIS/HUD computer-based trainer will be discussed in chapter three.



### III. METHODOLOGY

#### A. SYSTEMS DEVELOPMENT LIFE CYCLE

A systematic development method was used to create this computer-based trainer. The approach was broken into the common phases of the systems development life cycle and then further divided into more computer-based training related modules in an orderly fashion. This methodology focused the development from a macro view to a micro view without losing the intended goal of correct instructional design. Below is a figure representing the macro approach used; the detailed micro phases immediately following the figure.

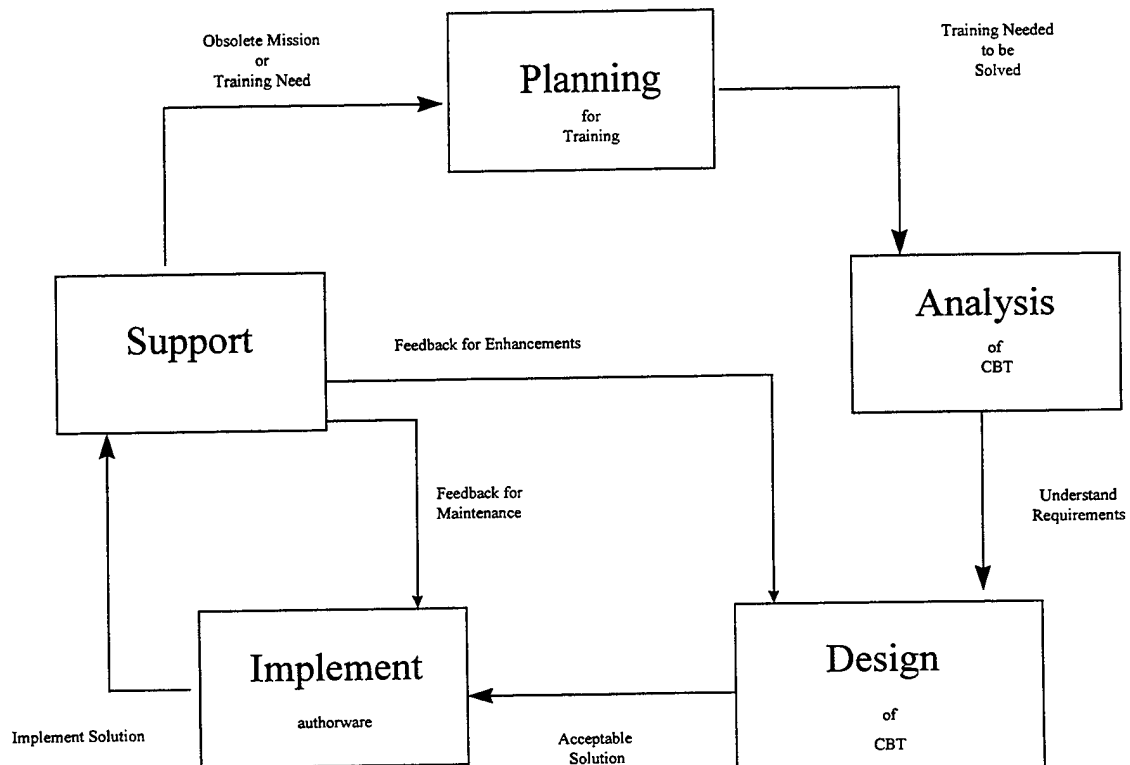


Figure 3.1 SDLC Process (Whitten, 1994)

## **B. PLANNING**

The military is continually planning for an efficient and effective method to conduct training. In the rotary wing community, specifically those identified in this thesis, the ANVIS/HUD system could use a CBT training method. ANVIS/HUD is relatively new to the rotary-wing community and the best way to train has yet to be identified.

## **C. ANALYSIS**

### **1. Analyze Needs**

The need exists for a local training system for the ANVIS/HUD throughout the rotary-wing community, specifically, in the Helicopter Combat Support Special Squadron (HCS-4, Red Wolves and HCS-5, Firehawks). The HCS community spends most of its training time in two primary missions: Combat Search and Rescue (CSAR) and Special Warfare (SPECWAR). The emphasis of these missions has been placed on conducting operations in the night environment. This has led both HCS squadrons to equip and qualify every pilot and aircrewman with night vision goggles. There are plans to incorporate the electronic innovation of heads-up display into the HH-60H aircraft flown by these squadrons; thereby, requiring the need for a local training method for the ANVIS/HUD.

## **2. Develop Audience Profile**

The audience profile is necessary to ensure the instructional design is compatible with the knowledge and skill level of the students. This computer-based trainer was created with the intent to be use by rotary wing pilots. The education level of the target audience is at least an undergraduate degree with some initial training in the operation of night vision goggles and heads-up display.

## **3. Write Objectives**

The lesson objectives were written to achieve an intended performance level. The desired outcome was designed by:

1. Explaining what the student should be able to accomplish.
2. Discussing under what conditions the learning will take place.
3. How well the performance must be in order to be considered competent.

## **4. Analyze and Outline Course Content**

A content outline helps in the order, detail, refinement and scope of the content that is to be included in the design. The content outline correlates the performance objectives with the subject matter included in the instruction. The computer-based training module created was designed to be a stand-alone CBT as well as an enhancement for the ANVIS/HUD baseline course. The enhancements used were three fold. First, the learning objectives were designed for specific performance requirements. Second, multimedia features were incorporated to motivate and stimulate the student. Third, a method for providing feedback into the revision process was incorporated. The learning objectives were not limited in scope; however, the multimedia included was limited by the type and content of media files on-hand.



## D. DESIGN

### 1. Layout Course Map

The course map provides a detailed schematic for the development and helps in organizing the production responsibilities. Additionally, it helps in gauging the amount of work required in each lesson and how it fits into the entire course. This organization forces the developer to sequence the computer-based training module logically and intuitively.

The course map is a framework that is used to visually represent the organization of the module so that its scope and sequence can be understood by the students. The course map is a “visual table of contents” and provides a “visual cue” of the content to the learner. That is, the student can see what parts of the course they have already seen, or those that remain to be seen. This mapping can be as detailed as necessary but should include units, lessons, pre-tests, post-tests, menus, overviews and introductions. The overview and introduction design will be explained next.

A course overview is an important part of the course that explains how to navigate within the CBT structure and what the navigation icons mean. The overview takes the opportunity to introduce the tone and character of the module. A unit introduction provides a place in the unit where you can designate a clear change in direction in the course. The three lessons developed in the experimental module are: (1) Night Vision Goggles Familiarization, (2) ANVIS/HUD Review and (3) Human Factors.

The introduction is a good place to incorporate: the title of the unit, the unit objectives, and any directions needed to complete the instruction. The introduction can

help the student stimulate his/her knowledge of things already learned. Additionally, a bridge can be built that ties what has already been learned to what will be forthcoming. This transition gives the entire module continuity and thus a relevance. An introduction should not be too complicated, its main purpose is to motivate the student and to correlate old information with new information.

## **2. Determine Teaching Strategies**

The learning objectives are at the center of the module design and are a description of a specific performance. This performance describes the intended result of instruction and not the process of instruction itself. The outcome of the course should be explicitly described as: (1) what should the learner be able to do? (2) under what conditions is the performance to be accomplished?, and (3) what level determines competency? The approach used here is to present information that incorporates a lesson in order to effectively motivate the students and stimulate their learning, retention and transfer of knowledge. This strategy is designed to help the pilot accomplish the stated learning objectives for each lesson.

### **3. Specify Learner Activities**

The purpose of determining the learning activities is to identify the strategies that will help the students learn the content and improve their performance. The activities used provided a close match between the characteristics of our target audience (pilots), the subject matter (Night Environment Operations) and the instructional strategies chosen. The learning discipline used for this module is technical training, consisting of procedures and familiarization of night vision operations. A brief review of the instructional strategy used is:

1. Pre-instructional: Module Overview: Explain how this instruction may help in training.
2. Information Presentation: Identify names and functions of ANVIS/HUD.
3. Student Participation: Read text, View graphics and video.
4. Testing: Instruction on how to complete the test, Multiple choice test, Provide feedback on test performance.
5. Feedback: Provide feedback to the producers for incorporation in revisions.

### **4. Create Storyboards**

A storyboard must be comprehensive and complete to be reliable enough to generate a media production plan or to begin authoring. The storyboard page has many fields that require bits of information. The most important field of all is the frame description. A frame provides a interaction opportunity between the user and the computer, specifically, a frame is a single idea presented by the computer via an individual display made up of text or multimedia. This frame presents what the learner will see as all of the elements are combined into a single instructional message. As a rule, the more complex the interaction, the more necessary a complete description of the frame or frames become.

There are numerous pitfalls to avoid when developing the storyboards. The checklist developed in Appendix (B) was used to create and evaluate each storyboard. A few of the common problems found during creation was inconsistent tone, undefined use of jargon, and improper use of colors. Other common problems to be aware of are, no standards in writing, graphics, and no clear course design. Additionally, there are tendencies to "over-design" the course which leads to interactions that go beyond what is necessary to achieve the instructional objective for each lesson.

The particular storyboard used in this CBT design, shown in Appendix (C), was used because the HH-60H ANVIS/HUD baseline training course employed a similar layout. This course is an experimental module designed to enhance the training of ANVIS/HUD and as such the "feel" and navigation controls are designed to be consistent with only slight modifications. For example, modifications are completed with regard to the navigation buttons which reduced code generation and thus provided efficiencies in computer processing.

## **5. Produce Media**

The ideal production of video would detail a video shot list which dictates the video production to be incorporated into the storyboard. This video shot list would specifically list all the objects needed to produce the shots required, whether it is a specific pilot, airframe, prop, or a time and location where the segment will be taken. Future versions of this CBT will employ a video shot list; however, there was no video shot list for this computer-based trainer. The video clips were received from the senior media researcher at Armstrong Laboratories and the bitmap files were excerpted from the Night Vision Training course.

## **6. Incorporate Testing**

Testing provides a measurement of what growth and abilities students have gained as a result of the instruction. Testing strategies help assess performance, analyze responses to individual items and identify superior achievements or deficiencies of the students. These activities assess the ultimate benefit that the student's have gained from their course of information. Additionally, the tests provide proof that learners have sufficient knowledge to meet the specified learning objectives. The tests used in this computer-based trainer are multiple choice and were designed to test the identified learning objectives. The required level of competency are addressed for each lesson in order to give the student a performance goal.

## E. IMPLEMENTATION TOOLS

### 1. Hardware and Software Used

The hardware used in the formation of this computer-based training system enumerated below was similar to the requirement addressed in the DOD's minimum desktop configuration (for multimedia) produced for the Defense Information Systems Agency (Williams, 1995).

1. CPU P5-166MHZ, Intel
2. RAM: 64MB EDO
3. CACHE: 256KB Pipeline Burst SRAM
4. Hard Disk: 2.1GB, 5200 RPM, 12MS seek
5. Floppy Drive: 1.44MB
6. Sound Blaster: 16-Bit
7. CD-ROM: 6 speed, 900KB/SEC, 128KB
8. CD-Writer: Hewlett Packard 4020I, SCSI interface
9. Multimedia Card: Matrox Millennium PCI with 4MB
10. Matrox Motion Pictures Experts Group (MPEG-1) hardware
11. Stereo Speakers: 10 Watts per channel
12. Mouse: Microsoft ergonomic
13. Keyboard: 104 Keys
14. Monitor: 21 inch Viewsonic
15. Peripherals:
  - Printer: Hewlett Packard LaserJet 4
  - Laser Disk: Sony Laservision videodisc LDP-1550
  - Vidoe Hi8: Sony VISCA video deck CVD-1000.
  - Scanner: Hewlett Packard ScanJet IICx.

There was four software products used during the production and they were:

1. Asymetrix Multimedia Toolbook, CBT edition 4.0: (Authorware)
2. Microsoft Office Professional: (Word, PowerPoint, Excel)
3. Deskscan: (Scanner)
4. Caere Applications: (Scanner)

## F. SUPPORT

A critique form, Appendix (D), is incorporated into the CBT to give the student a means of feedback. The main goal of the critique is to use the students' input to enhance future revisions.

## **IV. RESULTS AND DISCUSSION**

### **A. RESULTS**

The major emphasis of this thesis was to create a computer-based training module for the ANVIS/HUD system using an instructional design quality check-list Appendix (B). The results of these efforts are presented in a sequential method. The first area discussed will be the overview or course map which provides a macro view of the CBT. The second area will present the entire module's learning objectives. From the four lessons in the module only the Night Vision Goggles lesson are presented here. The Night Vision Goggles lesson provides an example to demonstrate the learning objectives, lesson structure, method of evaluation and the feedback procedure.

### **B. COURSE MAP**

The CBT was designed as one module consisting of four lessons.

1. The first lesson is an overview of the course.
2. The second is a review of basic Night Vision Goggles (NVG).
3. The third is a review of the ANVIS/HUD system.
4. The final lesson examines some human factors that must be considered when operating in the night environment.

The Night Vision Goggles lesson has two sub-lessons which consist of: Illumination Sources and Capabilities and Limitation of NVG's. The ANVIS/HUD review lesson is divided into three sub-lessons. First is components, second is Symbolology and Programming and third is Warnings and Cautions. The Human Factors lesson, will



be incorporated into a later version of the CBT, and will have two sub-lessons. Modules are anticipated to entail Visual Effects and Spatial Disorientation. Below, the entire module is represented pictorially.

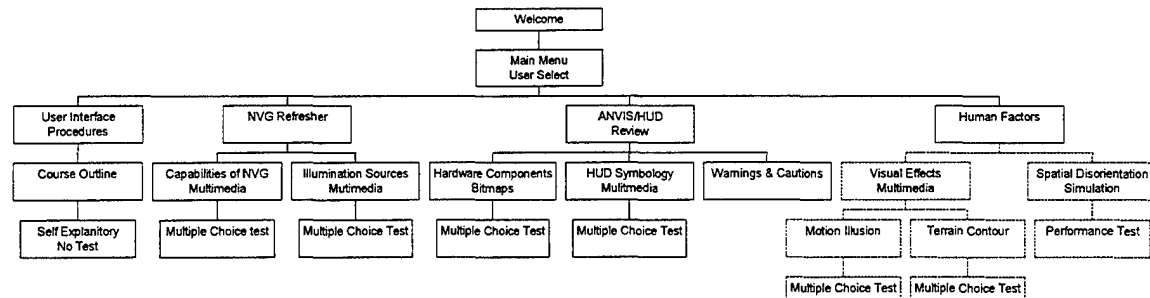


Figure 4.1 Course Map

The course map has helped considerably in the design, and division of labor throughout the development of the CBT. The students had the course overview presented in the first lesson of the CBT. This overview helps the student gauge the amount of work required for each lesson and how the lessons fit together as a course.

### C. LESSON OBJECTIVES

The module's lesson objectives were developed and incorporated into the computer-based training system. There are no objectives for the Course Overview lesson. However, there is lesson objectives relating to the NVG and the ANVIS/HUD lessons. These include:

#### 1. Night Vision Goggles (NVG)

**Lesson Description:** This lesson is divided into two night vision goggles sections, the first reviews capabilities and limitations of night vision goggles (NVG) and the second covers illumination sources while operating NVG's.

**Lesson Objective:** The student must be able to identify the capabilities and limitations of night vision goggles and identify the most common natural and artificial illumination sources for NVG's. This lesson will use text, video and sound to illustrate these objectives. When the lesson is complete the learner will be tested using a multiple choice examination. Competency of the material is established at eighty percent for both lessons.

**Learning Objectives:**

101.11 Identify the capabilities of military operations that are enhanced by the proper use of night vision goggles

101.12 Identify the most common natural and artificial sources of illumination while operating night vision goggles.

**2. ANVIS/HUD**

**Lesson Description:** This lesson is divided into three sections. The first, reviews the terminology and pictures of the ANVIS/HUD hardware components. The second, presents a review of symbology and basic procedures for mode selection and use of de-clutter options. The third reviews warnings and cautions of the ANVIS/HUD system.

**Objective:** The student must be able to correctly identify hardware components and procedures of the mode selection associated with the ANVIS/HUD system. Upon completion of each lesson the learning objectives will be tested with a multiple choice test, in which a one-hundred percent is required to demonstrate competency.

### **Lesson Objectives:**

**102.11** Identify all hardware components of the ANVIS/HUD system.

**102.12** Identify the steps and switchology for ANVIS/HUD mode selection and use of the de-clutter option.

**102.13** Demonstrate use of ANVIS/HUD operating procedures for mode selection and use of the de-clutter option.

### **3. Human Factors**

**Lesson Description:** This lesson is divided into two sections. The first reviews the visual effects and the second lesson is focused on spatial disorientation. The visual effects module is subdivided into motion illusion and terrain contour.

**Objective:** The student must correctly identify the learning objectives presented in this module. Upon completion of the lesson the student will be given a multiple choice test covering the objective. This module is not completed and therefore no specific learning objectives or competency levels are identified here.

### **D. LESSON EXAMPLE**

One of the Night Vision Goggle lessons, specifically the Illumination Sources, is presented as an example of the computer-based training system. There are twenty-five pages associated with the Illumination Sources sub-lesson, which is presented in Appendix (E). The intention of Appendix (E) is not to demonstrate the use of multimedia but to provide a feel of the course and its potential to transfer knowledge. As with every course of instruction feedback is essential for improvement and the form used for this computer-based trainer feedback is presented in Appendix (D).

## E. PROBLEMS ENCOUNTERED

As with the production of any product there are inevitably problems encountered and this product was not the exception. Many problems presented themselves but they were, for the most part, related to hardware, software and media. This section will provide some lessons to be aware of when developing a multimedia computer-based trainer.

Following the DOD guidelines (MILSTD 1379D) for computer multimedia development we envisioned only minor problems, however, there were numerous difficulties. The hardware difficulties were related to both internal motherboard and peripheral connectivity. The newly released Matrox Motion Pictures Experts Group (MPEG-1), hardware card was incompatible with the PCI Matrox video card installed in the computer. Numerous hours were spent trouble shooting the incompatibility. The Matrox company recently developed a software patch that eventually corrected the incompatibility. The Laserdisk and Hi8 were unable to be viewed until the video card was working in accordance with advertised specifications. These specific problems delayed the production of the computer-based training system.

The software or authorware used was Asymetrix Multimedia Toolbook, 4.0 CBT edition. The literature on this authoring tool indicated it could incorporate (MPEG) video files. However, it was not inherent to the tool. In order for this tool to use and incorporate (MPEG) files a computer patch in the language OpenScript had to be developed and is provided in Appendix(F). This set the stage for a critical time delay in the area of incorporating media into the computer-based trainer.

The media on-hand and available was provided on analog laser disk, and video Hi8 tapes. Once the hardware was capable of interfacing with the peripherals the laser disk and Hi8 were both viewed and used in production. Some specialized video requested supporting learning objectives was provided in the (MPEG) format. This media was viewable, however, it was not capable of being used in the CBT unless the patch was incorporated. The patch was not incorporated or used in this CBT because we were able to obtain the media in the Audio-Visual Interleaving (AVI) format which is supported and used in the authoring tool employed. The major lesson learned is when developing a computer-based training system is to plan for delays. These delays can come from a variety of inputs, however, we experienced the hardware incompatibility with peripherals and the nuances with software.

## V. SUMMARY AND RECOMMENDATIONS

This thesis was initiated based on a need specified by the Naval Air Systems Command, specifically to develop an additional training method for instruction of the ANVIS/HUD system. Previous research indicated two possible methods should be investigated. The first was the use of Helmet-Mounted Display-Based Part Task Trainer and the second was to develop Computer-Based/Multimedia technology to support on going classroom and NITE lab instruction. This thesis used multimedia technology to develop a computer-based trainer for the ANVIS/HUD system.

In order to ensure instructional design principles were followed the authors created an instructional design checklist for the development and evaluation of the computer-based trainer. Additionally, a systematic approach, detailed in chapter three, was used to develop the ANVIS/HUD computer-based trainer. The results of the research project will help future development of computer-based training systems.

The Department of Defense (DOD) and Department of the Navy (DON) are experiencing substantial budget reductions and this trend is not anticipated to change in the near future. The reduced funding has forced leaders to think in unconventional ways to accomplish the mission. Specifically, training pilots on the operations of the ANVIS/HUD system is essential to ensure personnel and equipment safety. Additionally, the mission success hangs in the balance of a well trained operator.

The CBT method of training has several advantages the military can capitalize on to stretch the training budget. The power of desk-top computers are increasing and the proliferation of the uses is evident at every command. The Helicopter Combat Support Services (HCS) squadrons have more than adequate computer equipment to support computer-based training.

The computer-based trainer developed here incorporated multimedia to enhance the knowledge transfer, however, there is no substitute for hands-on operation. The goal of this CBT is not to eliminate the use of classroom instruction, simulators or cockpit training, but to provide an augmentation to the ANVIS/HUD training method.

The new authorware available on the market permits the designers to export computer-based trainers on the World-Wide-Web (i.e., the Net). Current technological and cost limitations do not allow true full motion multimedia training to be conducted at the local command level. The World-Wide-Web could, however, be employed for providing feedback and discussion to the developing command. The Net would provide a way for the developer, Naval Postgraduate School, to ensure that the feedback is received and acted upon. Additionally, the Net could be used to provide a forum for presenting frequently asked questions about the ANVIS/HUD trainer. This forum would help in the dissemination of information and the incorporation of needed learning objectives in future version of the computer-based trainer.

It is also recommended that the NITE lab training developers and Naval Postgraduate School (NPS) work in conjunction to continue enhancing and developing the ANVIS/HUD computer-based trainer. Specifically, the use of the NITE labs

professional staff to script and film ANVIS/HUD operations of the training sorties. This media would be incorporated into a CBT, produced at NPS, and used in the ready rooms for pilot training and familiarization with the upcoming training flight operations.



## LIST OF REFERENCES

- Aarntzen, Diana., Audio in Courseware: Design Knowledge Issues, Education and Training Technology International, Vol 30 No. 4., November 1993.
- Albert, D. and Bitser, D. L.: Advances in Computer Based Education, Science, 1970.
- Alessi, Stephen M., and Stanley R. Trollip, Computer-Based Instruction: Methods and Development, Prentice-Hall, Englewood Cliffs, NJ, 1991.
- Ciavarelli, Anthony, Kishore Sengupta and Wolfgang Baer. Night Vision Goggle (NVG) Training Technology Report, Technology Report. Naval Postgraduate School, Monterey, CA, December 1994.
- Chapman, Bryan, L., Accelerating the Design Process: A Tool for Instructional Designers, CBT Solutions, August/September 1995.
- Chute, Alan, Distance Learning Futures, Asymetrix Developers Conference, 1996.
- Cronin, Karen, A. and Cronin, M. W., A Critical Analysis of the Theoretic Foundation of Interactive Video Instruction., Journal of Computer-Based Instruction, Spring 1992, Vol. 19, No. 2.
- Dean, Christopher and Quentin, Whitlock, a handbook of Computer Based Training, Nichols Publishing Company., New York ,1983.
- Epperson, Sean T., Animation Within a Multimedia Training System for Night Vision Goggles, Master's Thesis, Naval Postgraduate School, Monterey, CA, March 1995.
- Fletcher, J. D., Does This Stuff Work? Some Findings form Applications of Technology to Education and Training, Paper presented at the Conference on Teacher Education and the Use of Technology Based Learning Systems, Warrenton VA: Society for Applied Learning Technology, 1996.
- Fletcher, J. D., What Have we Learned about Computer Based Instruction in Military Training?, NATO Research Study Group, Workshop, Lessons Learned, September 1995.
- Gagne, R. M. and L.J. Briggs, Principles of instructional design, Holt, Rinehart, and Winston, New York, 1979.
- Gardner, William, Evaluation Criteria For Computer-Assisted Instructional Software As Assessed by California Educational Representatives., University Microfilms International, 1987.

Geber, Beverly, Beware the Glitz of Multimedia, Training: The Human Side of Business, A supplement, November 1994.

Geoghegan, William H., What Ever Happened to Instructional Technology?, Paper presented at the 22<sup>nd</sup> Annual Conference of the International Business School Computing Association, July 1994.

Gery, Gloria, Making CBT Happen, Weingarten Publications, Boston, 1987.

Glynn, William, Evaluation Criteria for Computer-Assisted Instructional Software, 1986.

Gotz, Klaus, Interactive Learning with the Computer, Education and Training Technology International, Vol 28, No. 1, pp. 7-14, February 1991.

Goverts, Kenneth C., and Thomas A. Grillo., Computer-Based Industrial Training: A Primer, Training and Development Journal, November 1984.

Jeiven, Helene, A Common-Sense Checklist for CBT, Training and Development 1994.

Kilby, Tim, Web-Based Training Information Center,  
URL: <http://www.clark.net/pub/nractive/alt3>

Kulik, James, A., Meta-Analytic Studies of Findings on Computer-Based Instruction., University of Michigan.

Lok, Joris J., "Computer Offer Training Efficiency", Jane's Defense Weekly, vol. 12, no. 5, August 5, 1989.

Mager, Robert, F., Preparing Instructional Objectives, Second Edition, Pitman Learning, Inc., 1984.

Mahoney, Francis X, and Nancy L. Lyday, Design is What Counts in Computer-Based Training, Training and Development Journal, July 1984.

Murphy, David., Is Instructional Design Truly a Design Activity?, Education and Training Technology International, Vol 29, No. 4.

Orr, Kay L., Golas, K.C., and Yao K., Storyboard Development for Interactive Multimedia Training, Journal of Interactive Instruction Development, Winter 1994.

Pable, Jill B., Architecture and Interior Design Computer Multimedia Applications: Issues and Common Procedures in the Incorporation of Video Sequences, JCAEDE 1 (1), 1995.

Shaffer, Kenan J. and Dabney R. Kern, Re-engineering a Computer-Based Trainer for a Helicopter Night Vision System, Master's Thesis, Naval Postgraduate School, Monterey, CA., May 1996.

Whitten, Jeffery L., Lonnie D. Bentley, and Victor M. Barlow, System Analysis and Design Methods, Third Edition, Irwin Inc., Boston, 1994.

Williams, J.L., Deputy Commander, Information Technology Standards, Multimedia Extensions to the DOD minimum Desktop Configuration.  
URL: <http://sc.ist.ucf.edu/~OTT/refs/stds/mmexten.htm>



## APPENDIX A. AUTHORING SOFTWARE EVALUATION

	Authorware 3	Everest Authoring 1.5	IconAuthor 7.0	Macromedia Director 4.0	Toolbook 4.0 CBT	Oracle Media Objects 1.0.5
<b>GENERAL</b>						
Accepts DLL	Y	Y	Y	Y		
Price	\$5000	\$4400	\$5000	\$1200	\$1300	\$500
Platforms	Win 3.1	Win 3.1	Win 3.1	Win 3.1	Win 3.1	Win 3.1
OLE 2.0 C/S	Y	N	Y	N	N	N
<b>DEVELOPER INTERFACE</b>						
Text Bases	N	N	N	N	Y	N
Zoom Views	N	N	Y	Y	Y	Y
Tool Box	Y	Y	Y	Y	Y	Y
Debugging	Y	Y	Y	Y	Y	Y
Security Access	N	N	Y	Y	Y	Y
Help Wizard	N	N	N	N	Y	Y
<b>PROGRAM</b>						
Scripting Lang.	N	Y	N	Y	Y	Y
Data Validation	N	Y	Y	N	Y	Y
Object Oriented	N	Y	Y	N	Y	N
Parameter Based	N	Y	N	Y	Y	Y
Procedural Scripting	N	Y	N	Y	Y	Y
Templates	Y	N	Y	N	Y	N
<b>USER INTERFACE</b>						
Alphanumeric	Y	Y	Y	Y	Y	Y
Check Boxes	Y	Y	Y	Y	Y	Y
Dialog Boxes	Y	Y	Y	Y	Y	Y
Drag & Drop	Y	Y	Y	Y	Y	Y
Pallettes	Y	N	Y	Y	Y	Y
Pull down menus	Y	Y	Y	Y	Y	Y
Radio Buttons	Y	Y	Y	Y	Y	Y
<b>NAVIGATION</b>						
Dynamic Hyper Links	Y	Y	N	Y	Y	Y
Forward/Backwar d	Y	Y	N	Y	Y	Y
Go To Commands	Y	Y	N	Y	Y	Y
Jumps To	Y	Y	N	Y	Y	Y



## APPENDIX B. CHECK-OFF LIST FOR EVALUATING CBT

TOPIC	YES	NO	COMMENTS
<b>I. General Design Factors:</b>			
Welcome Screen			
Course Title Screen			
Directions on how to use CBT			
Course Prerequisites			
Course outline			
Duration of Lesson: Max 30 minutes per			
<b>II. Instructional Content and Strategy:</b>			
<i>Purpose-Objective Consistency:</i>			
- Are course objectives consistent with stated purpose of lesson			
- Is the objective relevant to lesson goal			
- Is it accurate			
- Is it complete			
- Is objective critical to knowledge and skill requirement			
<i>Objective Adequacy:</i>			
- Is the learning objective adequate in terms of its construction and intent			
- Is behavior stated as observable action			
- Are performance conditions specified			
- Are performance criteria defined			

TOPIC	YES	NO	COMMENTS
<b>II. Instructional Content and Strategy:</b>			
<i>Objective-Test Consistency:</i>			
- Are test item consistent with learning objectives			
- Do test items measure the objectives specified for the course			
- Are performance requirements/conditions consistent with the learning objectives			
<i>Test Construction Adequacy:</i>			
- Are test items well-formatted			
- Are test items reliable and valid measure of required performance			
- Are test items well written, not ambiguous			
- Are test questions relevant			
- Are test questions well spaced			
- Is there a variety of question types			
- Are test instructions stated clearly			
- Can the answers be requested			
- Are test items evaluated for difficulty			
<i>Test Presentation Consistency:</i>			
- Are instructional presentations consistent with corresponding test items			
- Is information need to pass the test presented			
- Is there enough review and practice for student to pass required performance test			
<i>Presentation Adequacy:</i>			
- Does presentation provide all information to meet learning objective(s)			
- Is information complete			
- Are explanations clear			
- Are examples and corrective feedback provided			
- Can student get help when needed			



TOPIC	YES	NO	COMMENTS
<b>III. Display Screen Guidelines:</b>			
<i>Format:</i>			
- Consistent fonts, type and size			
- Consistent use of color (maximum of 4 colors per screen)			
- Consistent punctuation			
- Blank space at top, bottom and sides			
- All-capital letters used only for warnings or hints			
- Always place navigational icons in same location			
- The instructional windows in the same position and are of same size and consistent location			
- Blinking text or graphics (not to use)			
- Use graphics sparingly, when needed to improve learning value			
<b>IV. LANGUAGE and GRAMMAR:</b>			
<i>Culture Bias:</i>			
- Is bias language avoided			
- Is bias references avoided			
<i>Technical Terms and jargon:</i>			
- Are they explained			
- Are abbreviations used appropriately			
- Paragraphs not more than six to eight lines			
- Single spacing within paragraph			
<b>V. USER FUNCTIONS:</b>			
- Is backward paging available			
- Does the student control the pace			
- Can the student review material			
- Are there temporary termination and bookmarks available			
- Are there safety nets and barriers			
- Is on-line help available			
- Can student leave comments			

TOPIC	YES	NO	COMMENTS
<b>VI. QUESTIONS AND FEEDBACK:</b>			
- Highlight the letter corresponding to a menu or answer choice			
- Use neutral, nonjudgmental words such as "That was correct"			
- Begin the hint with the word "HINT"			
- Set the number of tries users are allowed to attempt each question based on the difficulty of the question			
- Use praise sparingly			
- If answer is wrong is explanation given			
- If answer is correct, reinforce the idea by restating in slightly different words			
<i>Menus:</i>			
- Is orienting information included			
- Is it clear how to make a choice			
- Is it clear how to change a choice			
<i>Quality of Feedback:</i>			
- Is it supportive			
- Is it clear			
- Is it corrective			
<i>On Completion:</i>			
- Is the lesson end indicated			
- Is the student taken or directed to correct termination point			
- Is the student given appropriate credit			

(1) The check-off list for evaluating a Computer-based training system has be derived from Computer-Based Instruction: Methods and Development; by Alessi and Trollip 1991; Making CBT Happen by Gery 1987 and A Common-Sense Checklist for CBT by Jeiven 1994. The key questions concerning instructional quality were adopted from Merrill, Reigeluth & Faust, 1979.

<p>Story Board No. _____ Topic _____ _____ of _____</p> <p>Learning Objectives: 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____</p> <p>Instructional Mode:  <input type="checkbox"/> Tutorial  <input type="checkbox"/> Demo  <input type="checkbox"/> Practice  <input type="checkbox"/> Test              <input type="checkbox"/> Written              <input type="checkbox"/> Performance       </p> <p>Media:  <input type="checkbox"/> Photo  <input type="checkbox"/> Graphics  <input type="checkbox"/> Video  <input type="checkbox"/> Sound  <input type="checkbox"/> Animation  <input type="checkbox"/> Simulation       </p>	<div style="border: 2px solid black; padding: 10px; text-align: center;"> <div style="border: 1px solid black; width: 100%; height: 100%;"></div> <div style="border: 1px solid black; width: 60%; margin: 0 auto; padding: 5px;"> <p>Instructions to the student</p> </div> <div style="border: 1px solid black; width: 100%; padding: 5px; margin-top: 10px;"> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="display: flex; gap: 5px;"> <div style="border: 1px solid black; padding: 2px 5px;">Last</div> <div style="border: 1px solid black; padding: 2px 5px;">Next</div> <div style="border: 1px solid black; padding: 2px 5px;">Previous</div> <div style="border: 1px solid black; padding: 2px 5px;">First</div> </div> <div style="display: flex; gap: 5px;"> <div style="border: 1px solid black; padding: 2px 5px;">Go To</div> <div style="border: 1px solid black; padding: 2px 5px;">Main Menu</div> <div style="border: 1px solid black; padding: 2px 5px;">Exit</div> </div> </div> </div> </div>
---	---

Review comments/changes: \_\_\_\_\_  
 \_\_\_\_\_



## APPENDIX D. FEEDBACK FORM

### Return Address:

Media Lab  
School of Aviation Safety, Code 10  
Naval Postgraduate School  
1588 Cunningham RD, Room 301  
Monterey, CA 93943-5202

Fax: Commercial: (408) 656-3262  
DSN: 878-3262

E-Mail: [medialab@nps.navy.mil](mailto:medialab@nps.navy.mil)

=====

### ANVIS/HUD Computer-Based Training Lesson Critique

Instructions: Please take a moment to provide your comments in the space given. Identify all areas that were especially good or bad. Be specific and offer recommendations on how the lesson can be improved.

Lesson Title: \_\_\_\_\_

Lesson Number: \_\_\_\_\_

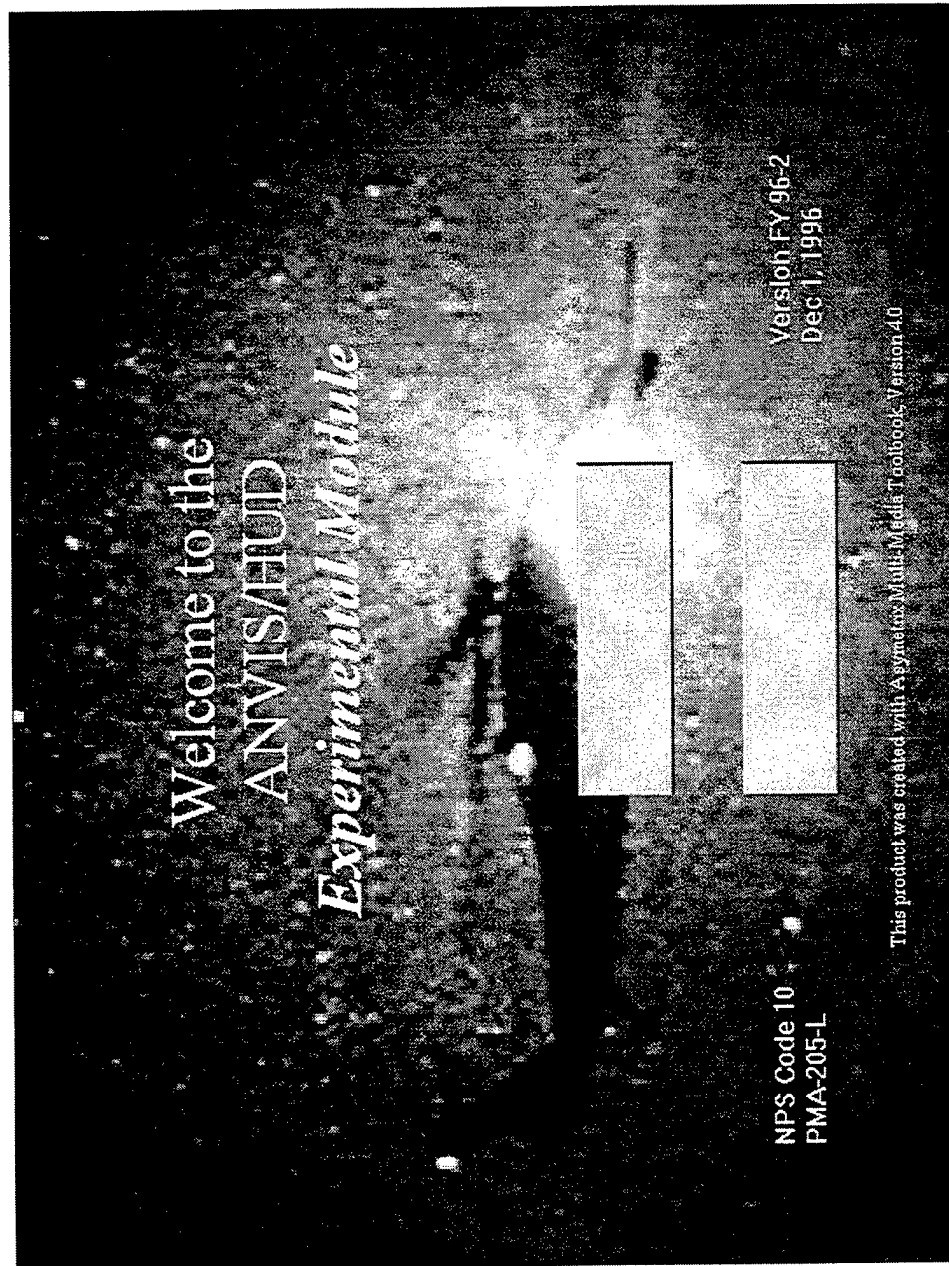
Date: \_\_\_\_\_

- =====
1. Were the Objectives pertinent?
  2. Were the Objectives clearly stated?
  3. Were the Objectives realistic?
  4. Was it easy to Navigate through the lesson?
  5. Any Enhancements you feel should be incorporated?
  6. What type of computer was used for this training? (PC, CPU speed, Monitor size, etc.)
  7. Overall how was the Subject Matter understandable?
  8. Overall was this training useful in teaching you to perform your mission?
  9. Overall how was the quality of instruction?
  10. What was the weakest area?
  11. What was the strongest area?
  12. Overall Evaluation of the Lesson:

\_\_\_\_\_ Unsatisfactory \_\_\_\_\_ Marginal \_\_\_\_\_ Satisfactory \_\_\_\_\_ Excellent \_\_\_\_\_ Outstanding  
Thank you for your input!



## APPENDIX E. ILLUMINATION MODULE



## Main Menu

User Interface Procedures

NVG Refresher

ANVIS/HUD Review

Human Factors

### Pressing Buttons

Use the mouse to select a menu entry by positioning the cursor over the button and then clicking the left mouse button.

Try these buttons below  
or choose from the main menu selection.

First

Previous

Next

Last

Exit



# NVG Refresher

Capabilities and Limitations of NVG

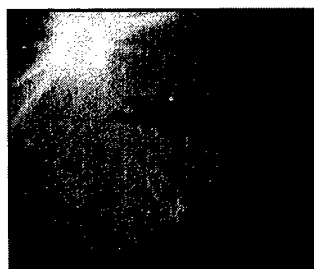
Illumination Sources

Portions of this module was created using the  
University of Dayton Research Institute's  
Night Vision Goggle Training Program

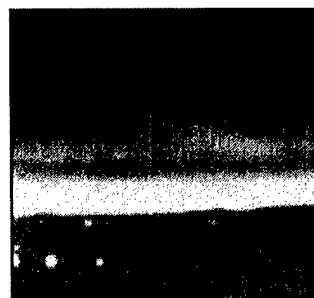
Main Menu

Exit

## Illumination Sources



Relative Moon position



Skyglow

This lesson is not meant to re-educate students on NVG operations, but to refresh them on the aspects of illumination sources. This lesson will examine various illumination sources that impact NVG operations. The illumination sources will be separated into two general categories, Natural and Artificial. Upon completion of the lesson there will be a multiple choice test covering the learning objectives below. Competency of the material is considered at ninety percent.

### Lesson Objective:

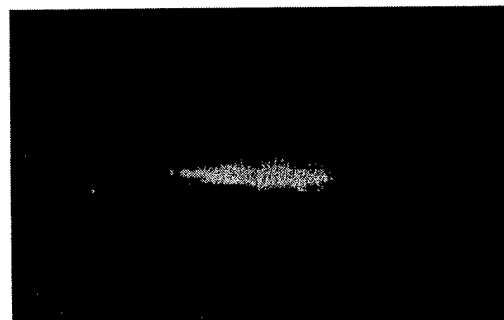
1. Identify common natural and artificial sources of illumination.
2. Identify how natural and artificial sources of illumination effect NVG operations.

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## Illumination Sources



Industrial site 80 miles away



Same site 5 miles away

NVG's ability to create an image during nighttime is better than the un-aided eye due to two factors:

- 1) NVG's are sensitive to a greater range of available energy in the night sky.
- 2) NVG's intensify the available energy to which they are sensitive.

First

Previous

Next

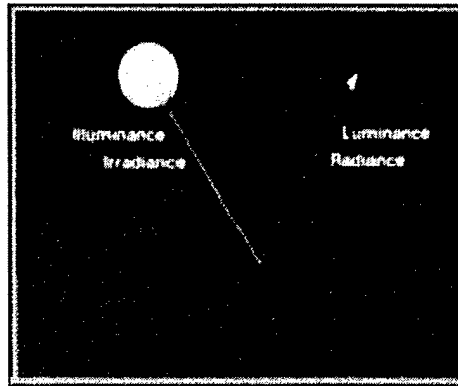
Last

Main Menu

Exit

## Illumination Sources

Luminance / Illuminance &  
Radiance / Irradiance



NVG's ability to create an image during nighttime is better than the un-aided eye due to two factors:

- 1) NVG's are sensitive to a greater range of available energy in the night sky.
- 2) NVG's intensify the available energy to which they are sensitive.

**Luminance**: The total amount of visible energy reflected from the surface.

**Illuminance**: The total amount of visible energy incident to a surface.

**Radiance**: The total amount of radiant energy reflected from a surface.

**Irradiance**: The total amount of radiant energy incident to a surface.

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## Illumination Sources

This scene depicts full moon with varied Albedo.

The student should notice the contrast (albedo) which provides a clear image.



In order for there to be an image, the scene must contain objects with different albedos. The more albedo differences in the scene the better the image.

Video of Albedo

**Albedo:** The fraction of incident electromagnetic energy reflected from the surface.

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## Illumination Sources

### Natural sources of Light



Quarter moon



Full moon

There are many sources of illumination, however, these are the most important contributions of Natural sources of illumination. But, the more illumination is not necessarily the best for the image quality.

Just to list a few:

Moon Light

Star Light

Chemical Reaction

Solar Light

Aurora

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## Illumination Sources

### Natural Illumination



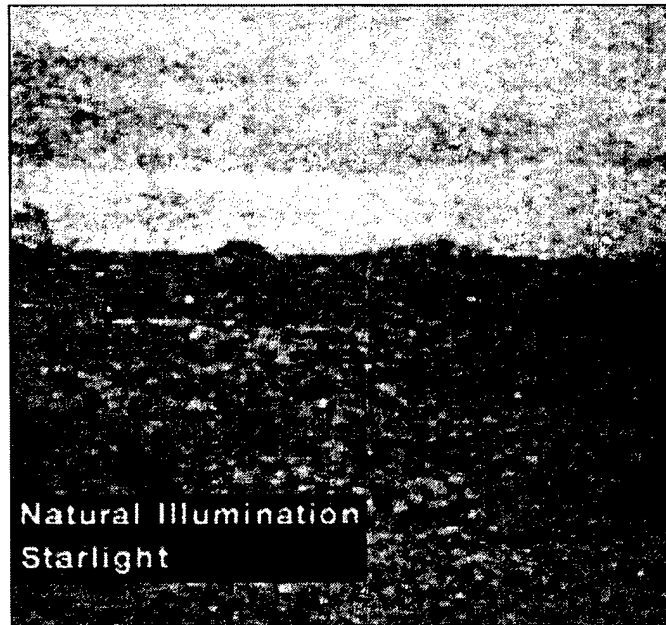
This photo depicts both the effects of Albedo and the light illumination received from a Full moon

**Moon Light:** Moonlight provides the greatest percentage of illumination present in the night sky by reflecting the sunlight. Even though current NVGs have a tremendous capability for Intensifying available energy, some moonlight is still required for most operations in which detail is needed in the NVG image.

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## Illumination Sources

### Natural Illumination



**Star Light:** There are about 8000 stars that are visible to the unaided eye, and approximately 2000 of them are visible on any night from either hemisphere. Though stars contribute some visible light, most of their contribution is in the form of near-IR energy. This can be appreciated by looking at the night sky with NVGs and noting how many stars can be seen compared to viewing with the unaided eye. They account for approximately 20% of the near-IR energy present on a moonless night.

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## Illumination Sources

Additional sources of Natural Illumination are:

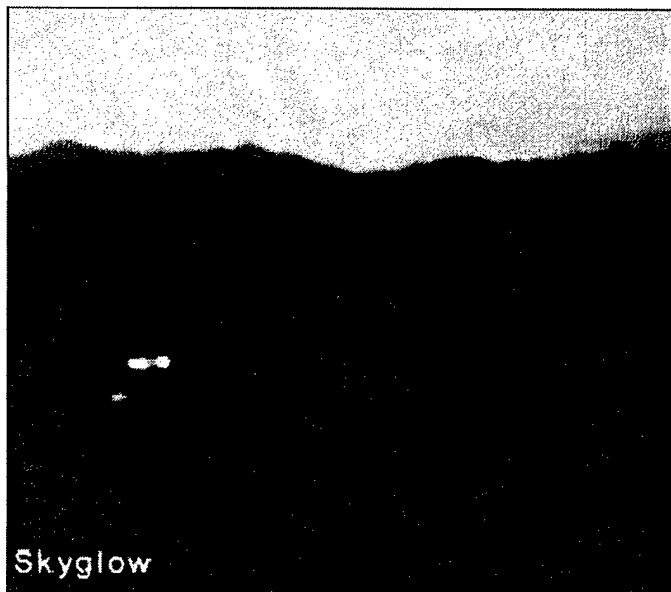
**Chemical Reactions:** Chemical reactions in the upper atmosphere account for the majority of near-IR energy present on a moonless night.

**Aurora Light:** The aurora and zodiacal lights are minor sources of near-IR energy. They result from the scattering of sunlight from interplanetary particulate matter.

**Solar Light:** Ambient light from the sun can be used by NVGs at certain times following sunset and before sunrise. However, it can also degrade NVG operations if not utilized correctly as will be demonstrated on video in the lesson entitled "The NVG Environment".

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## Illumination Sources



**Skyglow:** is an effect caused by solar light once the sun passes below the horizon. Skyglow remains in affect until the sun is approximately 18 degrees below the horizon.

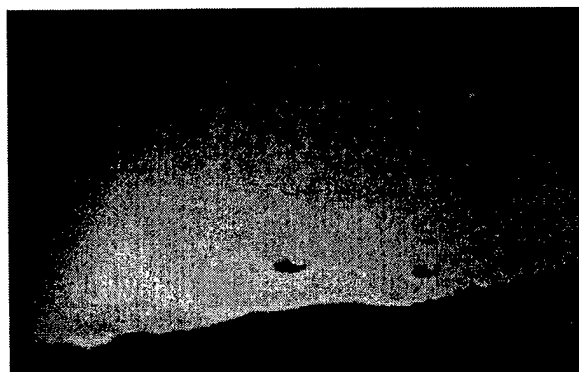
These skyglow effects last well beyond official sunset in middle latitudes.

Unlike sunset skyglow, sunrise skyglow does not effect NVG performance until fairly close to sunrise.

Scanning away from skyglow helps NVG gain readjust and image quality increase.

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## Illumination Sources



**Moonlight:** When present, the moon is the primary source of natural illumination in the night sky.

The size of the moon is not as critical to the NVG operations as is the variation or angle of its position.

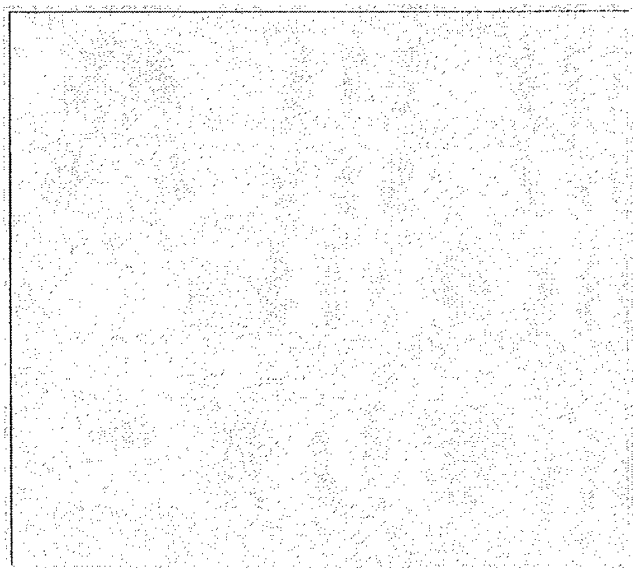
In the lower photograph the moon is approximately 10 degrees above the horizon in the NVGs field of view. This may cause image quality to decrease as the gain is driven down.

For NVGs to provide good images there must be contrast in the scene.

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## Illumination Sources

### Artificial sources of Illumination



Some of the more important sources of artificial illumination at night include:

City lights

Industrial sites

Cockpit lights

External aircraft lighting

Search lights

Video

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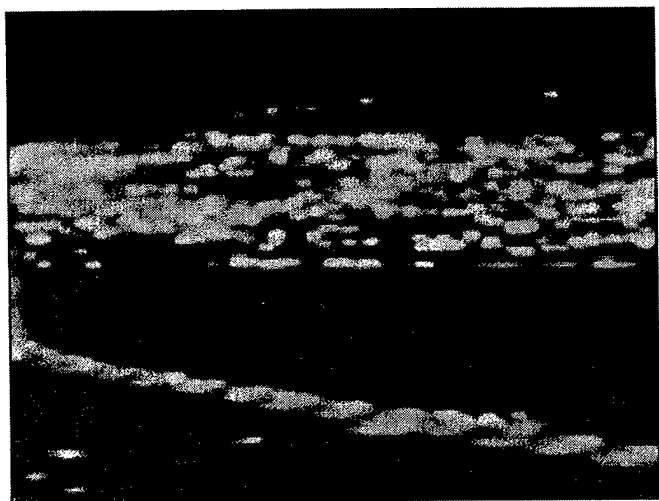
Last

Main Menu

Exit

## Illumination Sources

Artificial sources of Illumination



City of Tucson Arizona at 500' AGL

**City lights:** City lights, or cultural lights can be either helpful or detrimental to NVG operations based on variable such as:

The intensity of the light

The lights color

The lights location relative to the flight path

The number of lights

The proximity of the lights

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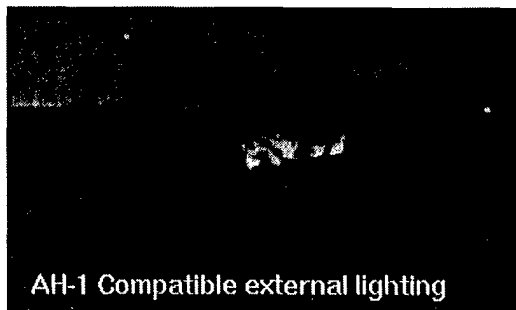
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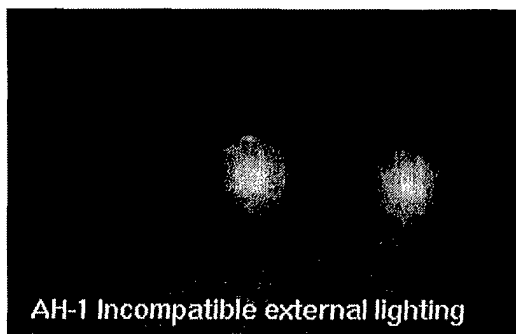
Exit

## Illumination Sources

### Artificial sources of Illumination



AH-1 Compatible external lighting



AH-1 Incompatible external lighting

### External Aircraft Lighting

NVG compatible external lighting is important to safe and effective operations.

Incompatible external lighting during NVG operations, such as in flight refueling or formation flying could make tasks more difficult or even dangerous.

Closure rate and direction of flight are difficult to determine when viewing an aircraft with incompatible lighting.

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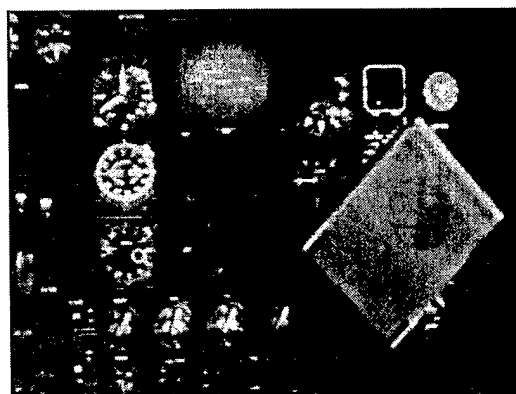
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## Illumination Sources

Artificial sources of Illumination



G-130 with Compatible cockpit lighting

### Cockpit Lighting

Any incompatible lighting in the cockpit will affect the NVG gain and the performance.

An incompatible light in the cockpit does not have to be within the NVGs field of view for it to have an effect on gain. The effect may not be obvious, but the image quality will be degraded.

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## Exercises

Use the mouse to click the most correct answer to the question shown

### Question 1 of 6

#### 1. Which of the following are NOT true?

1

The NVG will always produce a better image when the illumination level is equivalent to a full moon.

2

Due to the automatic gain function, the NVG will produce a good image regardless of how low the illumination level reaches.

3

The more albedo differences present, the better chance of having a good image.

4

NVGs rely on reflected energy to produce an image.

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## Exercises

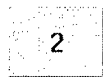
Use the mouse to click the most correct answer to the question shown

### Question 2 of 6

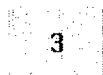
**2. Which of the following statements about Artificial sources of illumination are NOT true?**



City lights, searchlights and industrial sites are all sources of artificial illumination.



Most of the artificial sources contain energy in the form of visible wavelengths.



The brighter the artificial source of illumination the better the NVG performance.



Most artificial sources of illumination can adversely effect NVG performance and potentially create dangerous situations.

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## Exercises

Use the mouse to click the most correct answer to the question shown

Question 3 of 6

**3. Which of the following are natural sources of illumination in the night sky?**

1

Moon light

2

Star light

3

Chemical reactions

4

Aurora (Solar lights)

5

Cultural lights

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## Exercises

Use the mouse to click the most correct answer to the question shown

### Question 4 of 6

**4. Which of the following are not correct statements about the effects of skyglow on NVG performance?**

- ☐ 1 Once the sun sets below the horizon, it has no effect on NVG performance.
- ☐ 2 Skyglow caused by the rising sun does not impact NVG performance until near the time of sunrise.
- ☐ 3 Scanning away from the horizon will help decrease the effects of skyglow.
- ☐ 4 There is no difference between the middle and higher latitudes in the timing of skyglow effects.

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## Exercises

Use the mouse to click the most correct answer to the question shown

### Question 5 of 6

**5. Full moon illumination conditions will allow the NVG to produce a good image regardless of the level of contrast in the scene?**

True

False

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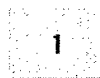
Exit

## Exercises

Use the mouse to click the most correct answer to the question shown

### Question 6 of 6

#### 6. Which of the following are NOT true?



A lighted complex such as a factory can be seen with the NVGs many miles away as long as there is nothing obstructing the view.



Most of the time, an individually lighted structure within a large lighted complex can easily be identified.



Since NVGs intensify the external lights of other aircraft, it is easy to keep track of their location even in urban areas.



If flying over a large urban area, it is sometimes possible to see more detail with the unaided eye by looking beneath or around the NVGs.

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the accompanying form  
or choose Main Menu button.  
Thank You

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## APPENDIX F. AUTHORIZING PATCH

Playing MPEG using OpenScript Commands: First, a system variable must be setup that contains the CD-ROM drive letter where the media is located. Then concatenate that system variable onto the file names of the medial files intended to be played.

In the script of the book place the following code in  
enterApplication handler (if there is one, if not create one)

```
to handle enterApplication
    send determineCDdriveLetter
end enterApplication
```

Second, two handlers are to be placed in the script of the book:

```
to handle determineCDdriveLetter
    systemcdDriveLetter
```

- the fileName variable should be assigned a file specified in the application.
- It should be a file that would only exist on your CD and not on any CD.
- Don't put a drive letter before the file name.

```
FileName= "files\myFile.tbk"
```

- look for the CD with your file until the file is found or the user quits.

```
CdDriverLetter = NULL
while cdDriverLetter is NULL
```

- this returns just a letter with no ":" or "\"
- ```
cdDriveLetter = cdDriveWithFile(fileName)
```

- if the CD was not found, alert user
- ```
if cdDriveLetter is NULL
```

- add a message for the user if CD is missing
- ```
cdMissingMessage = "This program requires a CD." \
& "Place CD in the CD-ROM" \
& "drive and press OK."
```

- give user a choice to look again or give up
- ```
request cdMissingMessage with "OK" or "Quit"
```

- what did the user choose?
- ```
if it is "OK"
```

- pause to give the drive a chance to read CD
  - then look again for CD(continue the loop).
- ```
Pause 5 seconds
else
    -user chose "Quit"
    -shutdown the program
```

```

        send exit
        break to system
    end if
end while

```

-after the loop, if the script is still running then we have a drive letter  
 -(if the user quit looking , the program exited).

End

-Look in all attached CD drives for pFileName (e.g. "media\frank.avi").  
 -If you find it return the frive letter (no following colon, i.e. "A" not "A:").

To get cdDriveWithFile pfileName  
 fileName = pFileName

-if the file isn't found the driveWithFile variable will remain NULL  
 driveWithFile = NULL

-link the necessary functions to get the drive information.  
 -use TB30DOS.DILL if your version of ToolBook is 3.0  
 linkDLL sysToolBookDirectory & "TB40DOS.DLL"  
 STRING getCDDriveList()  
 STRING getFileOnlyList(STRING,STRING,STRING)  
 end

-link to the Windows API error enabling/disabling function  
 linkDLL "Kernel"  
 INT SetErrorMode(INT)  
 end

-the CD drive many not have a disk in it.  
 -to avoid the error message that windows generates, turn off Windows error.  
 Get setErrorMode(1)

-getCRLF delimited list of all CD drives on the system  
 allCDDrives = getCDDriveList()

-step through each drive and check to see if the file is there  
 step I form 1 to textLineCount (allCDDrives)

```

--each drive is a separate textline
    cdDrive = textLine I of allCDDrives

--construct a version of name with the drive letter
    fileNameWithDirve = cdDrive & ":\\" & fileName

--get a list of all files with that name
--it should get a list of one file
    fileList = getFileOnlyList( fileNameWithDrive, ",", "")

--if the file list is not null, we just looked at the CD
--with the file so we have the correct drive letter
    if fileList is not NULL
        driveWithFile = cdDrive
        break step
    end if
end

--turn on windows error reporting again
get setErrorMessage (0)

--if the file wasn't found, the return value will be NULL
    return drive WithFile
end

```

This third handler is an example of how you might use the cdDriveLetter system variable to play a media file using callMCI, and how it would be placed in the script of a n object, perhaps a button.

```

To handle buttonClick
    system cdDriveLetter
    fileName = cdDriveLetter & ":\avi\batmanf.avi"
    get callMCI ("open" & & filename & & "alias testClip1 wait")
    get callMCI ("play testClip1 wait")
    get callMCI ("close testClip1")
end buttonClick

```



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